

WHAT IS CLAIMED IS:

1. A magnetoresistive film comprising a
multilayered film including: a pinned magnetic layer having
5 magnetization whose direction is fixed; a nonmagnetic middle
layer formed on the pinned magnetic layer; and a free
magnetic layer formed on the middle layer and provided with
magnetization whose direction changes in accordance with an
external magnetic field, and indicating a magnitude of
10 resistance in accordance with an angle formed by the
magnetization direction of the pinned magnetic layer and the
magnetization direction of the free magnetic layer,

wherein a copper oxide layer of an oxide including a
copper element is formed directly on said free magnetic layer,
15 or on the free magnetic layer via an oxide layer comprising a
material fabricated by oxidation of a material constituting
the free magnetic layer.

2. The magnetoresistive film according to claim 1
20 wherein said copper oxide layer has a thickness of 10
angstroms or more.

3. The magnetoresistive film according to claim 1
wherein said oxide layer has a thickness of 5 angstroms or
25 ✓ more.

4. The magnetoresistive film according to claim 1

wherein a protective layer for protecting the copper oxide layer is formed on said copper oxide layer.

5 5. The magnetoresistive film according to claim 4 wherein said protective layer comprises an oxide.

6. The magnetoresistive film according to claim 5 wherein said protective layer comprises Al_2O_3 .

10 7. The magnetoresistive film according to claim 1 wherein said free magnetic layer has a thickness of 30 angstroms or less.

15 8. A magnetoresistive film comprising a multilayered film including: a pinned magnetic layer having magnetization whose direction is fixed; a nonmagnetic middle layer formed on the pinned magnetic layer; and a free magnetic layer formed on the middle layer and provided with magnetization whose direction changes in accordance with an
20 external magnetic field, and indicating a magnitude of resistance in accordance with an angle formed by the magnetization direction of the pinned magnetic layer and the magnetization direction of the free magnetic layer,

25 wherein said middle layer has a thickness of 34 angstroms or less, and

 a coupling layer for exerting a coupling field for directing the magnetization of said pinned magnetic layer and

the magnetization of said free magnetic layer in opposite directions between the magnetizations is formed on said free magnetic layer.

5 9. A magnetoresistive head comprising a magnetoresistive film as a multilayered film including: a pinned magnetic layer having magnetization whose direction is fixed; a nonmagnetic middle layer formed on the pinned magnetic layer; and a free magnetic layer formed on the middle layer and provided with magnetization whose direction changes in accordance with an external magnetic field and indicating a magnitude of resistance in accordance with an angle formed by the magnetization direction of the pinned magnetic layer and the magnetization direction of the free magnetic layer, and detecting the magnitude of the resistance of the magnetoresistive film to detect a strength of the external magnetic field,

10 wherein a copper oxide layer of an oxide including a copper element is formed directly on said free magnetic layer, or on the free magnetic layer via an oxide layer comprising a material fabricated by oxidation of a material constituting the free magnetic layer.

15 10. An information regeneration apparatus comprising a magnetic head, disposed in the vicinity of or in contact with a magnetic recording medium on which information is recorded by a magnetization direction, for detecting the

magnetization direction of each point of the magnetic recording medium, and regenerating the information in accordance with the magnetization direction of each point of said magnetic recording medium detected by the magnetic head,

5 wherein said magnetic head comprises a magnetoresistive film as a multilayered film including: a pinned magnetic layer having magnetization whose direction is fixed; a nonmagnetic middle layer formed on the pinned magnetic layer; and a free magnetic layer formed on the middle layer and provided with magnetization whose direction changes in accordance with an external magnetic field, and indicating a magnitude of resistance in accordance with an angle formed by the magnetization direction of the pinned magnetic layer and the magnetization direction of the free magnetic layer, and detects the magnitude of the resistance of the magnetoresistive film to detect a strength of the external magnetic field, and

10 a copper oxide layer of an oxide including a copper element is formed directly on said free magnetic layer, or on 15 the free magnetic layer via an oxide layer formed of a material fabricated by oxidation of a material constituting the free magnetic layer.

20 11. A magnetoresistive film manufacture method for manufacturing a magnetoresistive film as a multilayered film including: a pinned magnetic layer having magnetization whose direction is fixed; a nonmagnetic middle layer formed on the

pinned magnetic layer; and a free magnetic layer formed on the middle layer and provided with magnetization whose direction changes in accordance with an external magnetic field, and indicating a magnitude of resistance in accordance with an angle formed by the magnetization direction of the pinned magnetic layer and the magnetization direction of the free magnetic layer,

said method comprising:

a free magnetic material layer lamination step of laminating said middle layer, and subsequently laminating a free magnetic material layer including a material constituting said free magnetic layer on the middle layer;

a metal layer lamination step of laminating a metal layer comprising a metal on the free magnetic material layer laminated in said free magnetic material layer lamination step; and

a plasma oxidation step of exposing the metal layer laminated by said metal layer lamination step to oxygen in a plasma state to oxidize the metal layer.

12. The magnetoresistive film manufacture method according to claim 11 wherein said plasma oxidation step comprises a step of oxidizing said metal layer, and a part of said free magnetic material layer on the side of the metal layer.

13. The magnetoresistive film manufacture method

according to claim 11 wherein said plasma oxidation step is performed simultaneously with lamination of a new layer on said metal layer.

5 14. A magnetoresistive film manufacture method for manufacturing a magnetoresistive film as a multilayered film including: a pinned magnetic layer having magnetization whose direction is fixed; a nonmagnetic middle layer formed on the pinned magnetic layer; and a free magnetic layer formed on
10 the middle layer and provided with magnetization whose direction changes in accordance with an external magnetic field, and indicating a magnitude of resistance in accordance with an angle formed by the magnetization direction of the pinned magnetic layer and the magnetization direction of the
15 free magnetic layer,

 said method comprising:

 a free magnetic material layer lamination step of laminating a free magnetic material layer comprising a material constituting said free magnetic layer on said middle
20 layer;

 an oxidation control layer lamination step of laminating a predetermined oxidation control layer on the free magnetic material layer laminated in said free magnetic material layer lamination step; and

25 ✓ a plasma oxidation step of exposing the oxidation control layer laminated by said oxidation control layer lamination step to oxygen in a plasma state to oxidize said

free magnetic material layer to a predetermined depth in a thickness direction from an oxidation control layer side through the oxidation control layer.

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